



# **CalEnergy Operating Corporation**

## **Salton Sea Geothermal Resources**

**California Biodiversity Council**

**March 18, 2009**

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# MidAmerican Energy Holdings Company

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- Seven Primary Business Platforms:
  - **MidAmerican Energy**
    - Distributes electricity and natural gas to 1.3 million customers in Iowa, Illinois, South Dakota and Nebraska.
  - **Northern Electric U.K.**
    - Distributes electricity to more than 3.6 million customers in the Northeast of England and across Britain.
  - **CalEnergy**
    - Owns and operates power plants in Illinois, Arizona, California, New York, Texas and the Philippines.
  - **Kern River Gas Transmission Company**
    - Owns and operates a 1,643-mile gas pipeline from Southwestern Wyoming to near Bakersfield, California.
  - **Northern Natural Gas**
    - Owns and operates 16,600 miles of pipeline from Texas to the upper Midwest.
  - **HomeServices**
    - Second-largest residential real estate brokerage company in the United States, based on closed transactions.
  - **PacifiCorp**
    - Distributes electricity to 1.6 million customers in Washington, Oregon, Idaho, Wyoming, Utah and California.

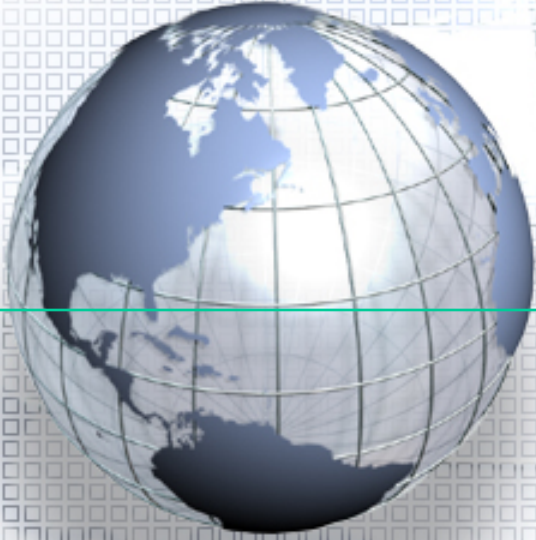


# MidAmerican Energy Holdings Company

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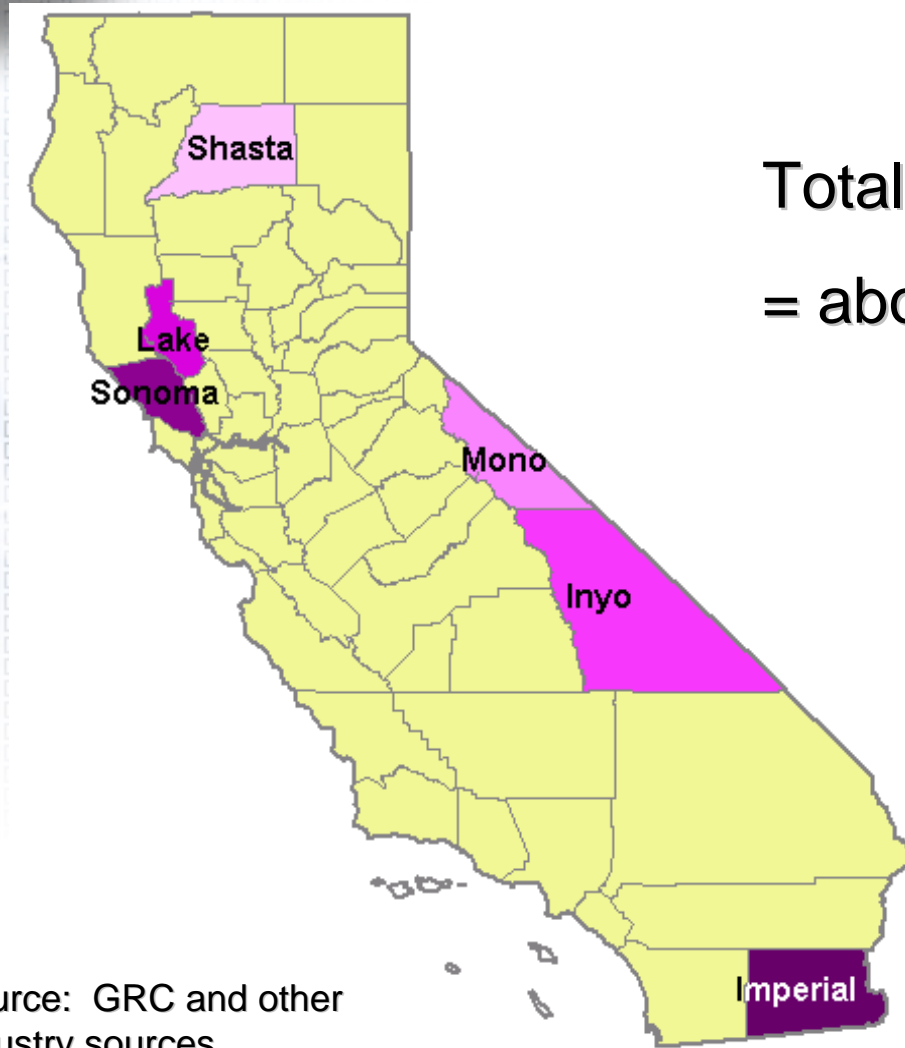
- Executive offices - Omaha, Nebraska
- Corporate headquarters - Des Moines, Iowa
- Privately owned by a four-party investor group - Berkshire Hathaway is the largest shareholder
- Business in U.S., U.K., Philippines, Poland and Australia
- Approximately 6.9 million electric & gas customers
- Approximately \$12.7 billion annual operating revenue
- Approximately \$41 billion in total assets
- Approximately 16,800 employees
- Approximately 21,500 MW of total generation capacity
- Non-carbon Generation 5,100 MWs
- Natural Gas Transmission Pipeline Design Capacity 7.0 billion cubic feet/day
- [www.midamerican.com](http://www.midamerican.com)

# Imperial Valley and Geothermal Energy

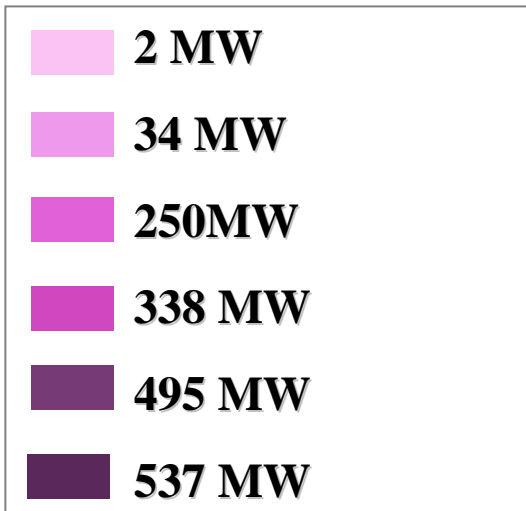




# Developed Geothermal Power Production In California



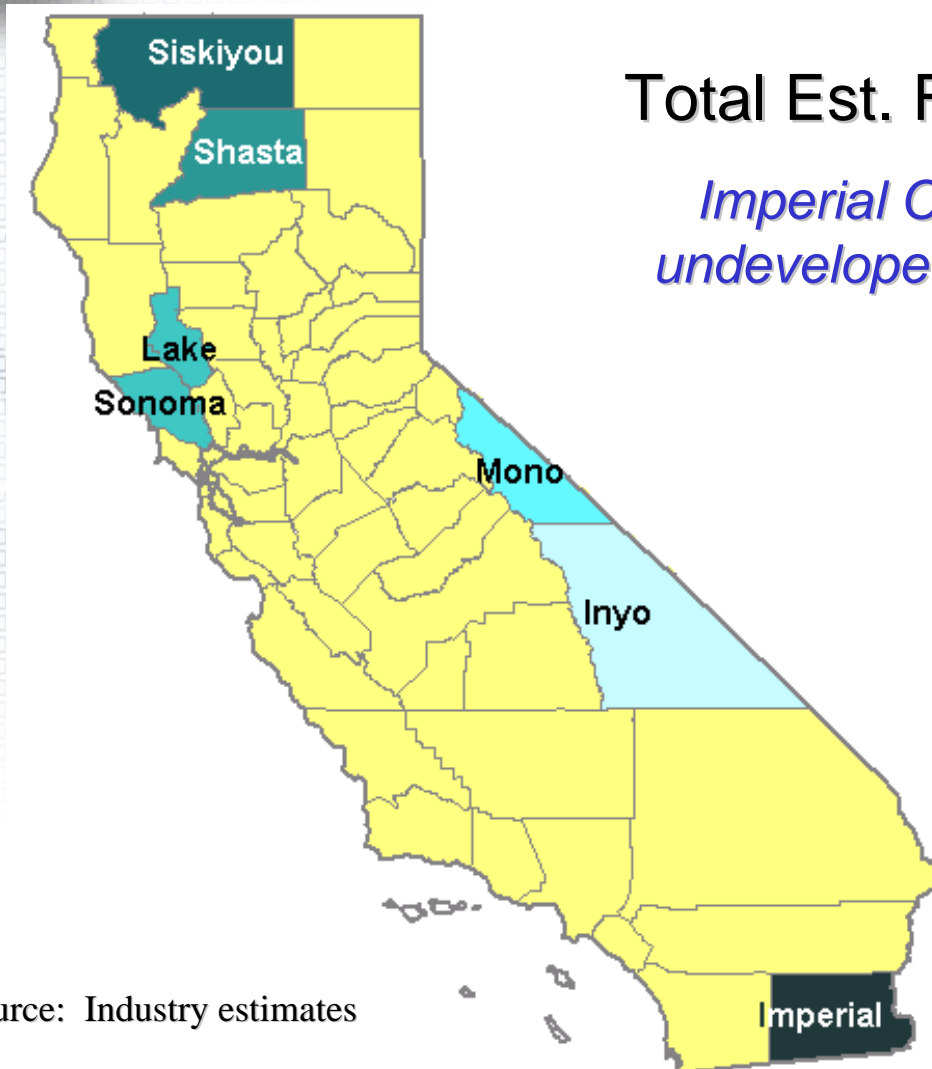
Total developed: 1,656 MW  
= about 20% world capacity



Source: GRC and other industry sources.

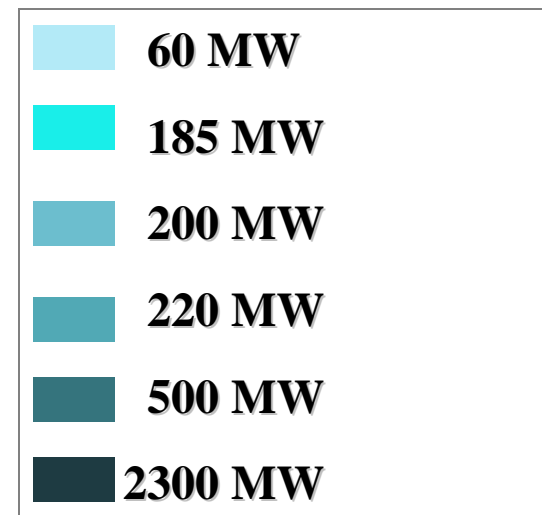


# New Geothermal Development Opportunities in California



Total Est. Future Potential: 3,465 MW

*Imperial County contains the largest known undeveloped geothermal resource in California and possibly the world.*



Source: Industry estimates



# What is geothermal energy production?

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- Geothermal production wells tap into superheated water reservoirs thousands of feet beneath the Earth's surface to release tremendous pressure, caused by the hot water, which rushes to the surface.
- There, steam is separated and used to drive turbines to generate electricity.
- Eight of the Imperial Valley facilities are under contract to sell power to Southern California Edison Company under 30-year power purchase agreements. Salton Sea 5 sells a portion of its output to the City of Riverside and the balance is sold into the California Power Grid.
- Power from the CE Turbo plant is sold to Arizona Public Service Company.



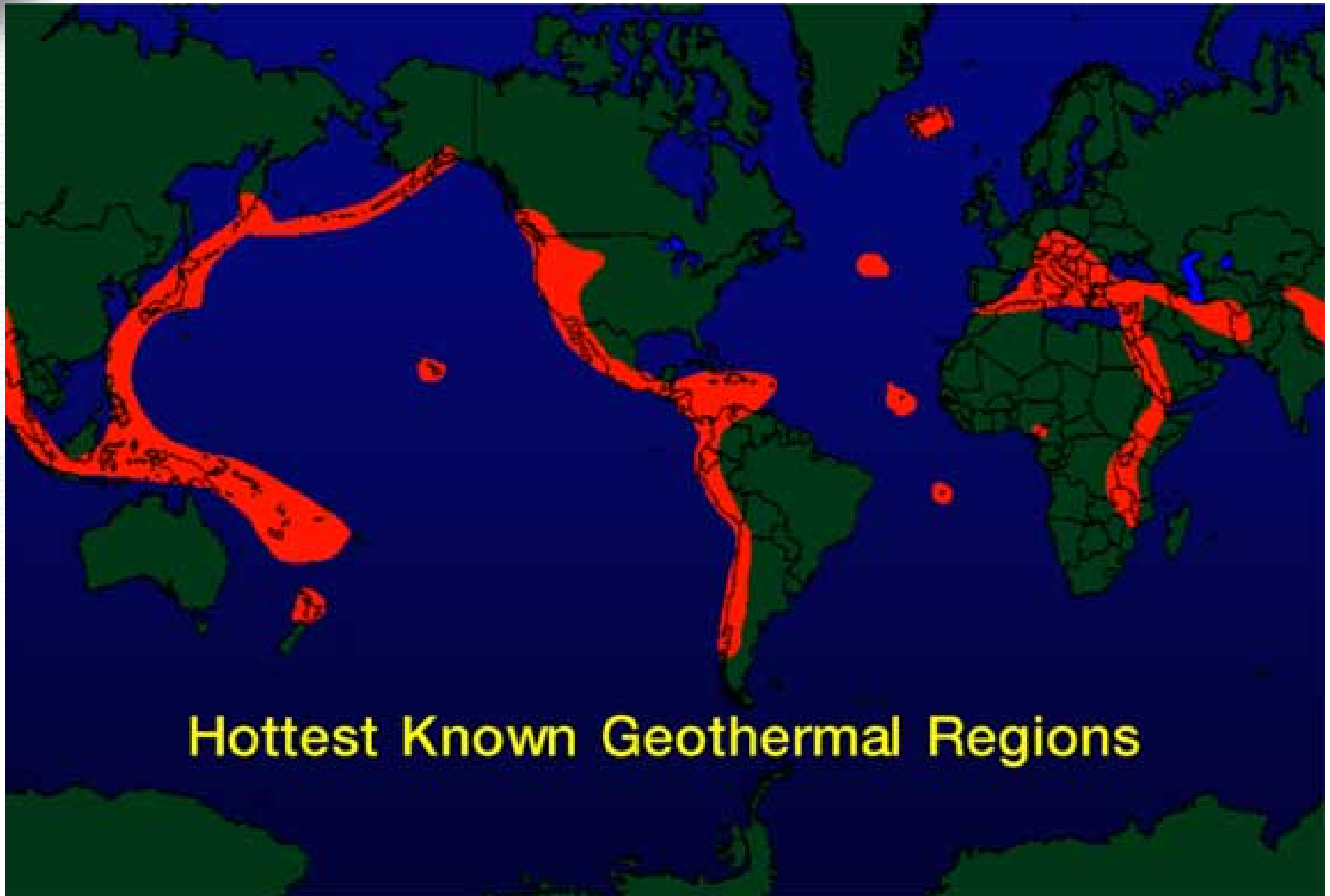
# Benefits of Geothermal Energy

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- In-situ, domestic, renewable fuel source
- Creates energy price certainty; insulation from fuel price volatility
- Dramatically reduced emissions
- High number of jobs per MW versus similar size fossil fuel based generation
- High impact on economic development resulting from high up front capital investment
- Co-exists with wildlife and agriculture
- In Imperial Valley – proven resource, proven technology, proven operator, strong owners, strong local support
- In California – preferred supplier to meet investor owned utilities' Renewable Portfolio Standard mandate and municipal utility demand

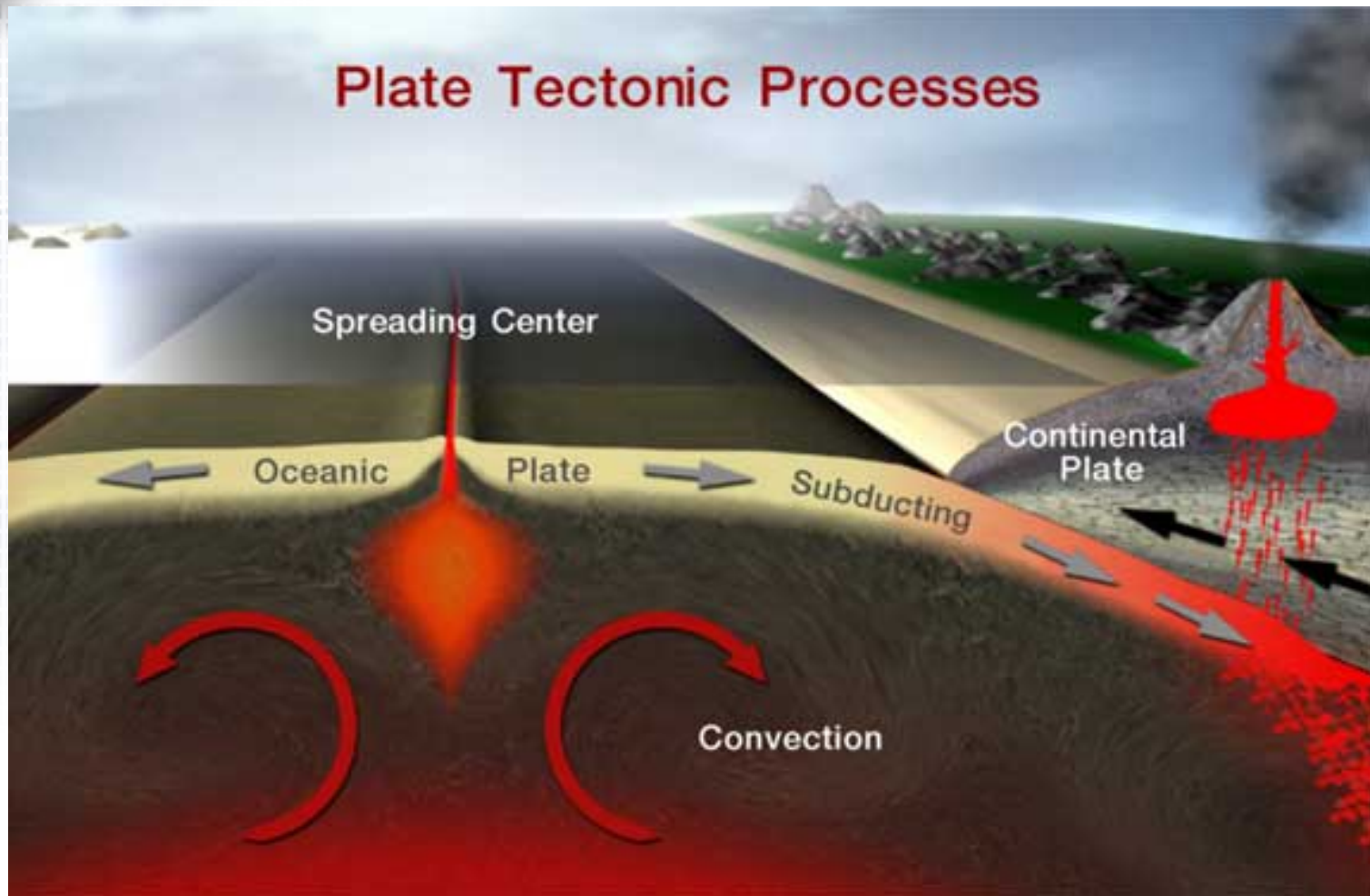


# Global Geothermal Resources





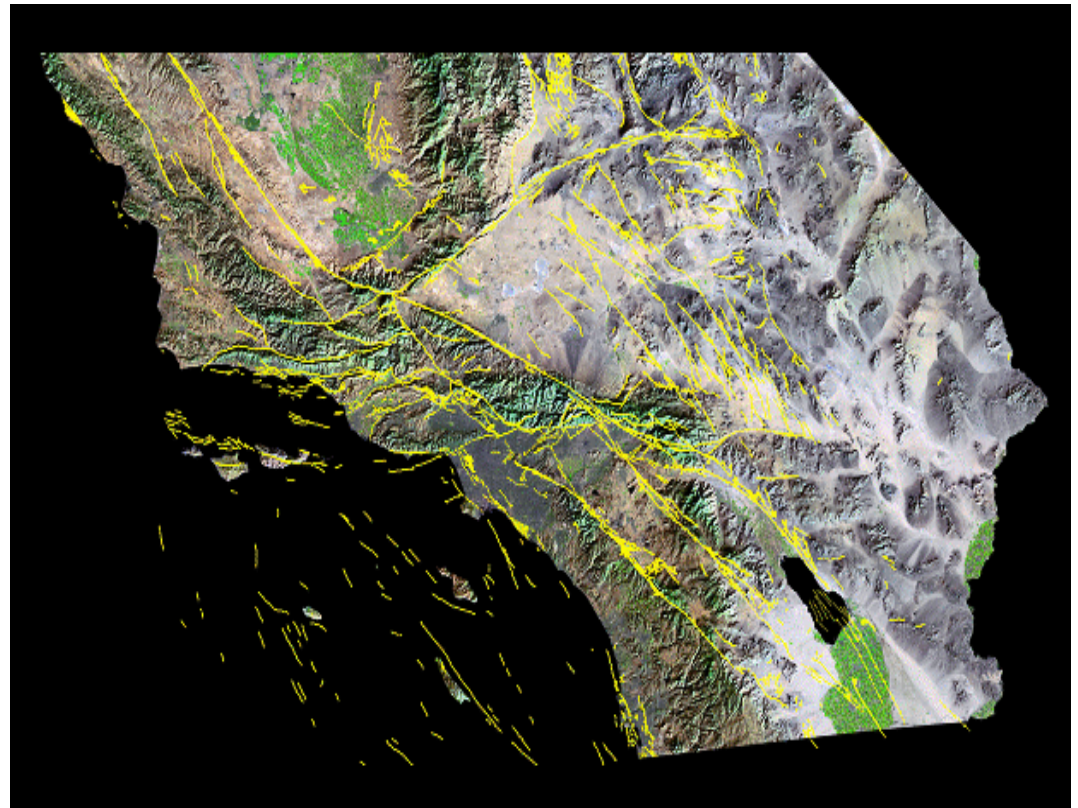
# Field Formation





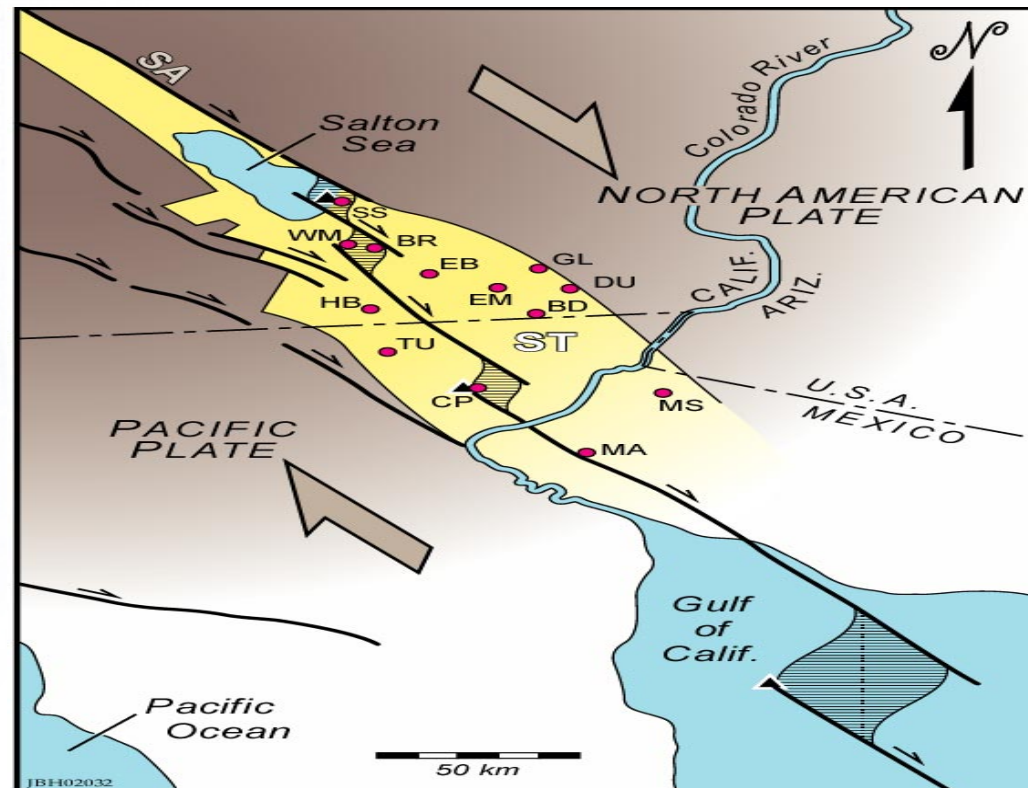
# Part of Major Global Fault System







- Within Major Faulting through California
- Near end of San Andreas Fault
- Faulting continues into the Gulf of California





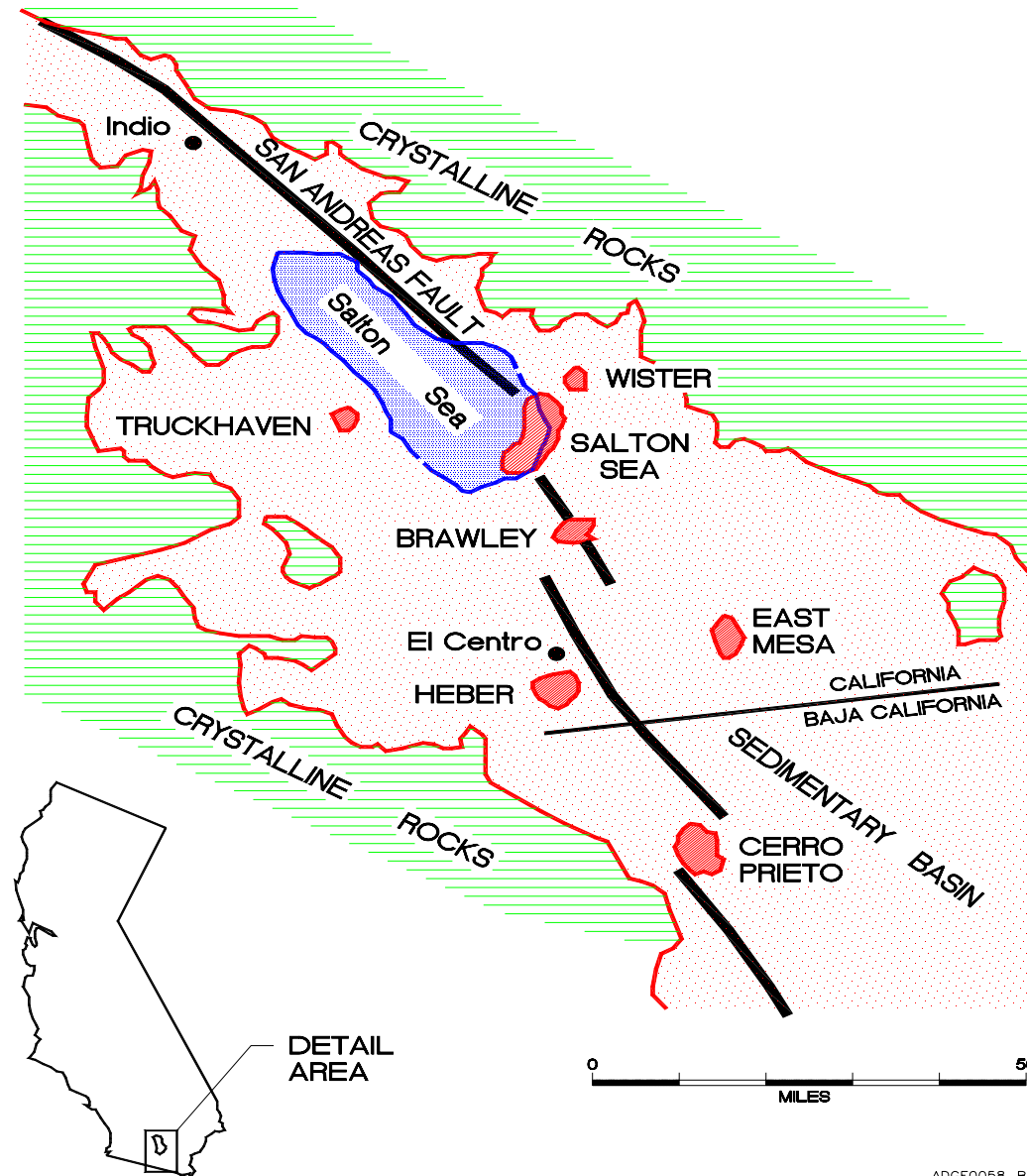
# Geologic Settings and Plate Tectonics



-  Extent of "normal"<sup>1</sup> crystalline continental crust according to Fuis and Hohler(1984)
  -  4-5 m.y.-old incipient continental rift zone
  -  Pull-apart zone at extensional overstep
  -  Geothermal fields
  -  Quaternary volcanoes
  -  High-angle faults; arrows show displacement
- <sup>1</sup>Quotation marks are the writers'

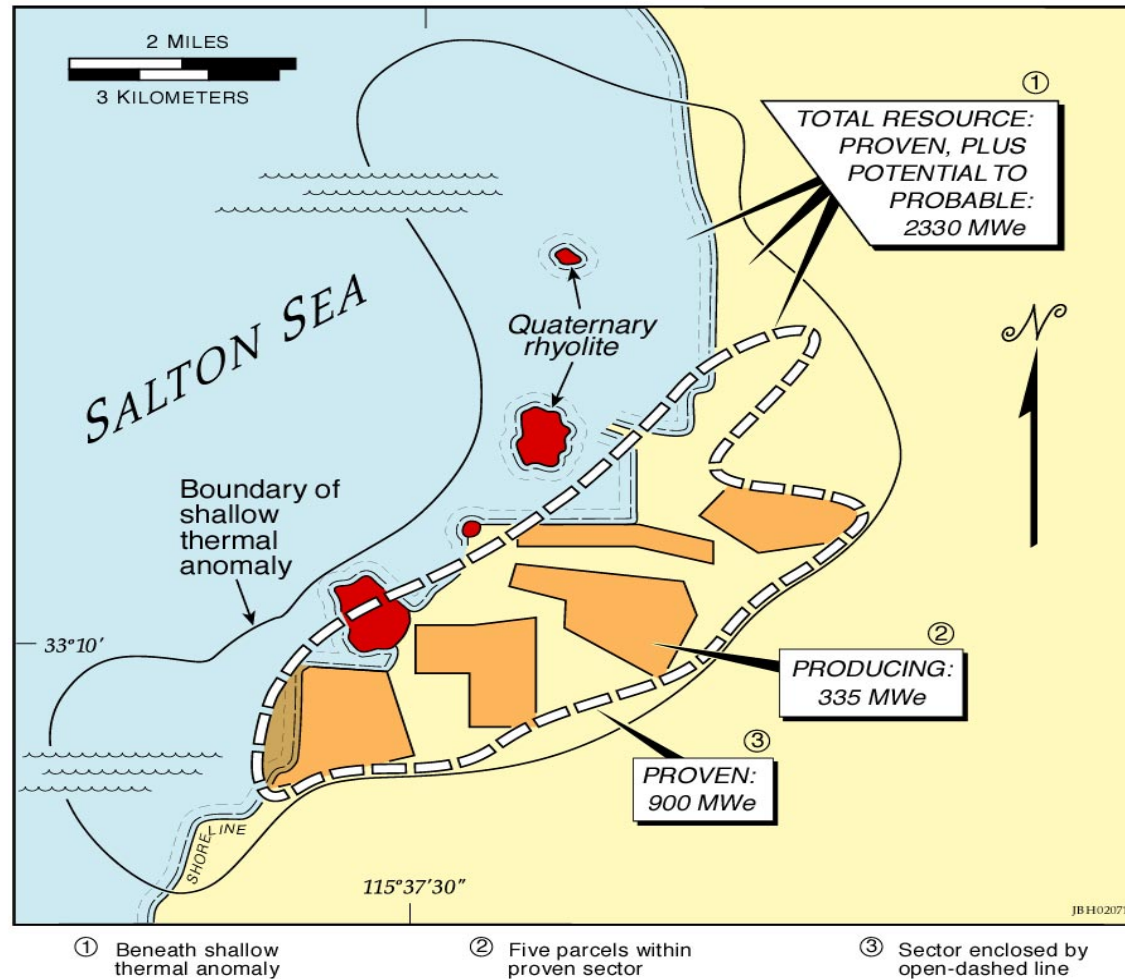


# Imperial Valley Geothermal Areas





# Most Recent Estimate of Resource Potential





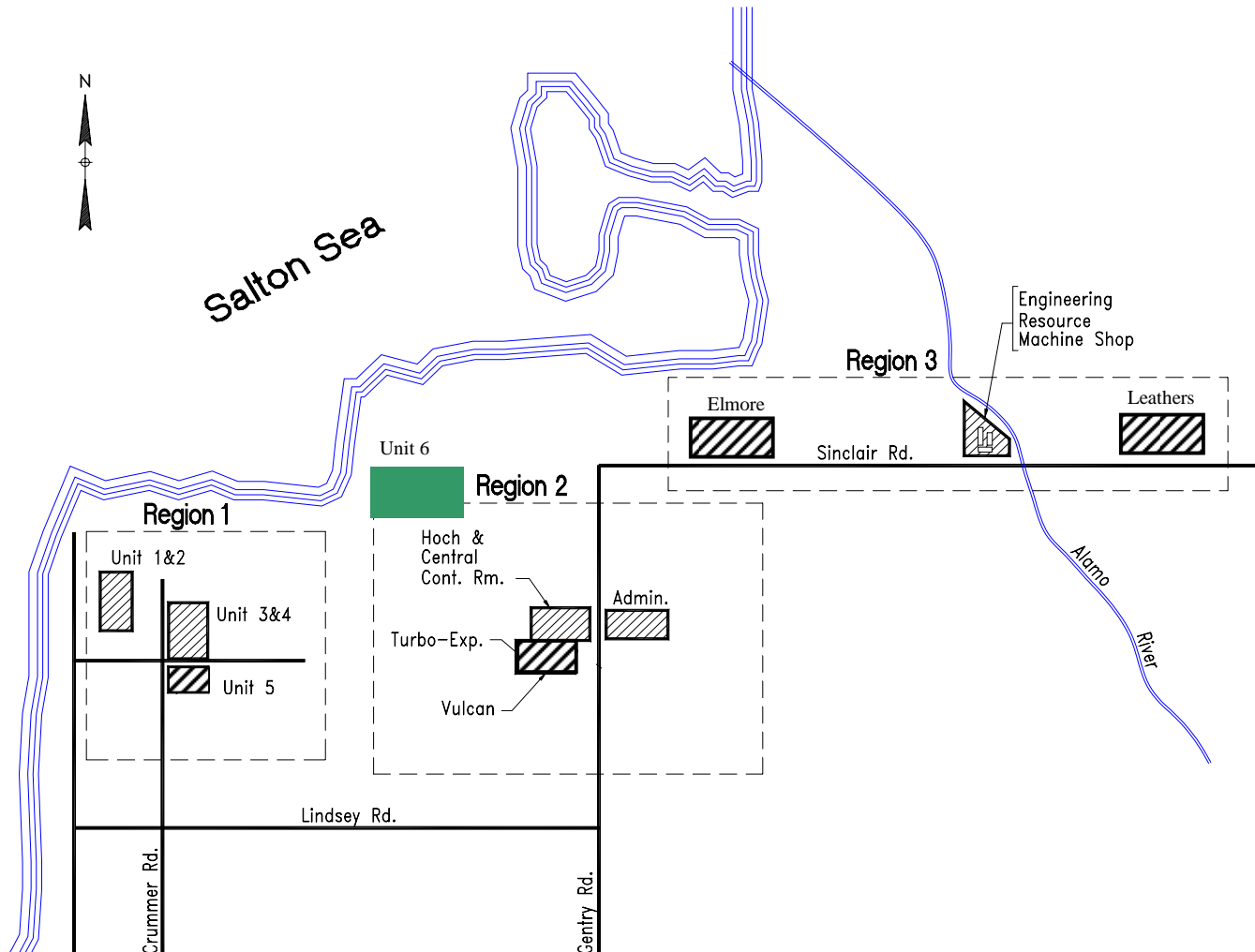
# History of Imperial County Geothermal Development

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- 1957
  - First geothermal well, Sinclair-1, drilled near the Salton Sea in Imperial County, California. Sinclair-1 was completed in Spring 1958.
- 1979
  - The first electrical development of a water-dominated geothermal resource occurs, at the East Mesa field in eastern Imperial County, California. The plant is named for B.C. McCabe, a geothermal pioneer and founder of Magma Power Company.
- 1982
  - First geothermal power plant (Unit 1, 10 MW) built at Salton Sea by a joint venture between Union Oil Company of California (Unocal) and Southern California Edison.



# Imperial Valley Operations





# Plant Development Chronology

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	<u>Start-Up</u>	<u>Contract MW</u>	<u>Maximum MW</u>	<u>Technology</u>
Unit 1	1982	10.0	10.0	Modified pH-Mod
Vulcan	1986	29.5	38.0	pH-Mod/CRC
Hoch	1989	34.0	42.0	pH-Mod/CRC
Elmore	1989	34.0	42.0	CRC
Unit 3	1989	47.5	50.0	<b>Modified pH-Mod</b>
Unit 2	1990	15.0	18.0	<b>Modified pH-Mod</b>
Leathers	1990	34.0	42.0	CRC
Unit 4	1996	34.0	42.0	<b>Modified pH-Mod</b>
Unit 5	2000	-	46.0	<b>Modified pH-Mod</b>
Turboexpander	2000	<u>-</u>	<u>10.0</u>	pH-Mod/CRC
Total		238.0	340.0	



# Salton Sea Geothermal Brine

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(Typical Weight %)

Chloride	15.40
Sodium	5.27
Calcium	2.65
Potassium	1.65
Carbon Dioxide	0.17
Iron	0.15
Manganese	0.14
Zinc	0.05
Silica	0.05
Strontium	<u>0.03</u>
Total Dissolved Solids & Gases	25.69

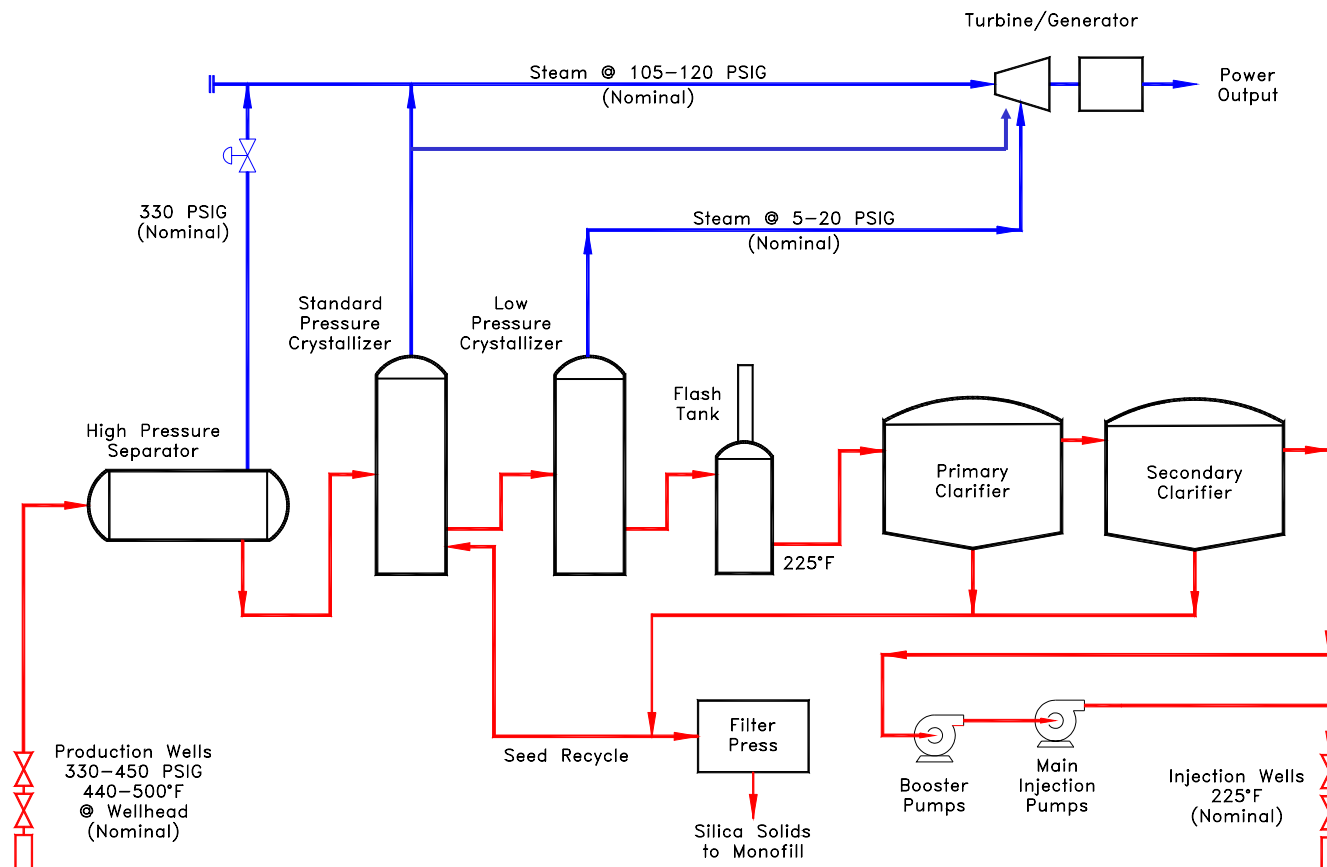


# Crystallizer / Reactor Clarifier Process

## Simplified Block Flow

CalEnergy

Crystallizer/Reactor Clarifier Process  
Simplified Block Flow



odge0018.dwg



# Key Issue: Scaling

Salton Sea Field  
Imperial Valley, CA



Severe Scaling from  
Hot Geothermal Brine  
Flow Through Pipelines





# Key Issue: Corrosion



Severe Corrosion from Hot Geothermal Brine Flow Through Carbon Steel Pipe

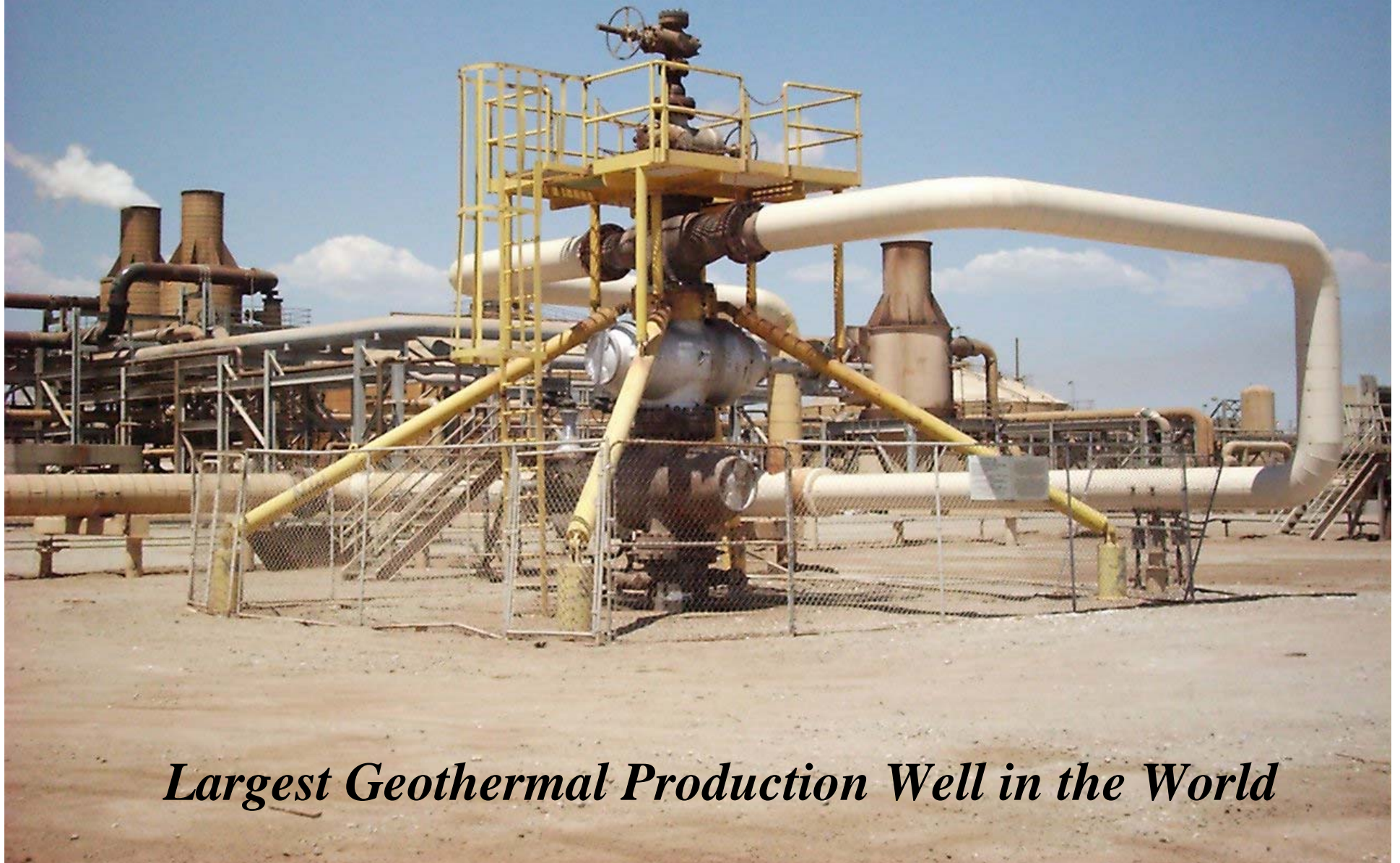


# Salton Sea Wellfield

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- 23 production wells, ~460 deg F, ~400 psig
  - 5,000 feet to 8,700 feet deep
- 21 injection wells, ~225 deg F, 0 to 350 psig
  - 5,500 feet to 9,200 feet deep
- 10 plant, pond and condensate wells
- 25 monitoring, observation and other inactive wells
- Total brine production 2.2 million barrels per day
  - Consider total Iraq oil production is 2 to 3 million bpd by volume
  - 55,000 bpd oil equivalent by energy content
- Vonderahe 1, ~50 MW well, largest in world
  - 274,000 bpd (Consider typical Saudi oil well is 10,000 bpd)

# *Vonderahe-1 Production Well*



*Largest Geothermal Production Well in the World*



# SONNY BONO SALTON SEA NATIONAL WILDLIFE REFUGE





# GEOTHERMAL DEVELOPMENT CO-EXISTS WITH AGRICULTURE



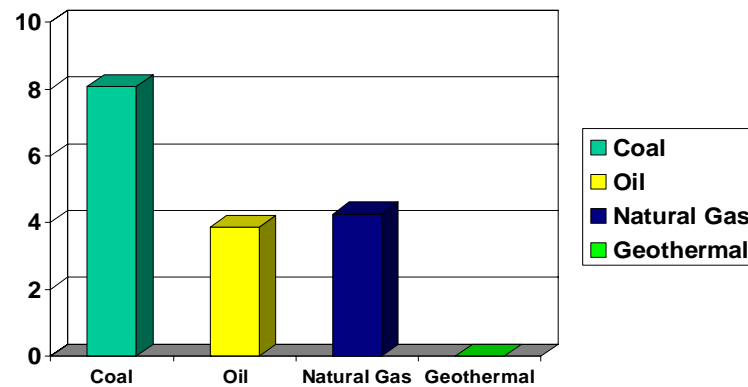


GEOTHERMAL  
ENERGY  
DEVELOPMENT ALSO  
CO-EXISTS WITH  
WILDLIFE

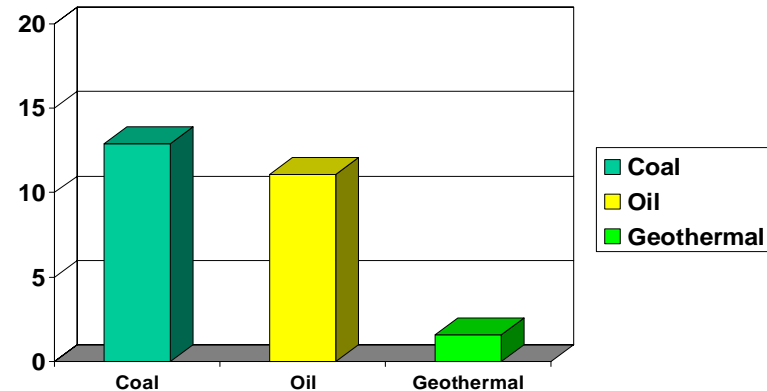


# Clean, Green, Environmentally Responsible Energy

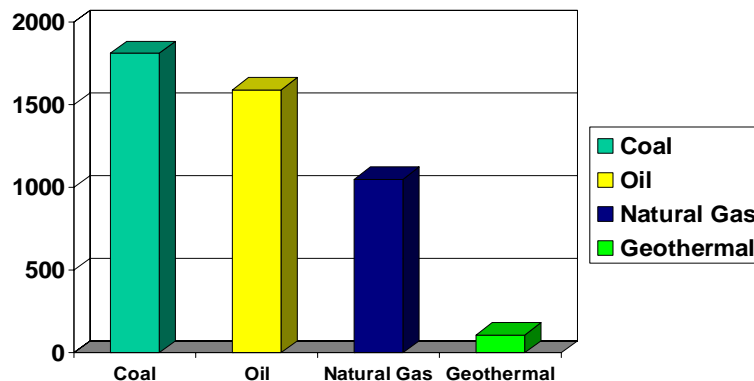
Nitrogen Oxides, NO<sub>x</sub> [lbs/MWh]



Sulfur Dioxide, SO<sub>2</sub> [lbs/MWh]



Carbon Dioxide, CO<sub>2</sub> [lbs/MWh]



Each year 22 million tons of carbon dioxide, 200 thousand tons of nitrogen oxides and 110 thousand tons of particulate matter are not emitted to the atmosphere because we used electricity from geothermal resources rather than burning fossil fuels.

Source: Geothermal Education Office  
& US Department of Energy